Urinalisis Multi-Output Berbasis ResNet50 untuk Implementasi Prediksi Kadar Protein, pH, dan Specific Gravity = ResNet50 Based Multi-Output Urinalysis for Implementation of Protein, pH, and Specific Gravity Prediction

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Abstrak

Proteinuria merupakan indikator adanya penyakit gagal ginjal yang ditandai dengan konsentrasi protein yang tinggi pada urine. Urine manusia dengan konsentrasi protein melebihi 0,15 g/L dianggap abnormal dan dapat diindikasikan sebagai penderita proteinuria. Secara berkolerasi, tingginya konsentrasi protein dalam urine menyebabkan pH urine semakin rendah dan specific gravity urine semakin tinggi. Beberapa tahun terakhir, dikembangkan sistem urinalisis berbasis deep learning menggunakan citra ponsel pintar. Namun, sistem ini hanya mampu memprediksi satu kadar analit urine tertentu, sesuai dengan target yang ditentukan. Pada penelitian ini, dikembangkan sistem urinalisis multi-output berbasis citra kamera ponsel pintar menggunakan model ResNet50 yang mampu melakukan pengukuran terhadap kadar protein, pH, dan specific gravity urine secara serentak. Urinalisis dilakukan dengan memanfaatkan kolorimetri pada strip uji celup urine URIT 11G. Citra strip uji dan papan warna referensi (X-Rite ColorChecker) diambil menggunakan kamera ponsel pintar, kemudian diproses menjadi bentuk barcode uji. Barcode uji digunakan sebagai input model dengan output berupa prediksi kadar analit dalam urine. Hasil penelitian ini menunjukkan bahwa model urinalisis multi-output berhasil dibangun menggunakan arsitektur CNN ResNet50 dengan akurasi sebesar 96,63% pada output klasifikasi serta mampu melakukan prediksi kadar analit secara regresi dengan performa R2 dan RMSE berturut-turut sebesar 0,9487 dan 0,0951. Performa tersebut menunjukkan bahwa sistem urinalisis multi-output berhasil dibangun dengan performa yang dapat bersaing dengan model urinalisis single-output, secara lebih efisien karena hanya menggunakan satu model ResNet50 untuk menghasilkan 6 output prediksi berbeda.
.....Proteinuria is an indicator of kidney disease characterized by high protein concentration in urine. Human urine with protein concentration exceeding 0.15 g/L is considered abnormal and indicative of proteinuria. Correlatively, elevated protein concentration in urine leads to lower urine pH and higher specific gravity. In recent years, a deep learning-based urinalysis system using smartphone images has been developed. However, these systems are only capable of predicting a specific analyte level in urine according to predetermined targets. In this study, a multi-output urinalysis system based on smartphone camera images was developed using the ResNet50 model. This system is capable of simultaneously measuring protein, pH, and specific gravity levels in urine. Urinalysis was conducted using colorimetry on URIT 11G urine dipstick tests. Images of the dipstick tests and reference color board (X-Rite ColorChecker) were captured using a smartphone camera and processed into test barcodes. The test barcodes were used as inputs for the model, which generated predictions of analyte levels in urine as outputs. The results of this study demonstrate that a multi-output urinalysis model was successfully built using the ResNet50 CNN architecture. It achieved an accuracy of 96.63% in classification output and was able to predict analyte levels through regression with R2 and RMSE performances of 0.9487 and 0.0951, respectively. These performances indicate that the multi-output urinalysis system was successfully developed with competitive performance compared to single-

output urinalysis models, but with greater efficiency as it only utilized one ResNet50 model to generate six different prediction outputs.